

PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Electric Heating Cables

I, HENRY HOPE BRUCE, a British Subject, of Grand Buildings, Trafalgar Square, London, W.C.2, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improvements in insulated electric heating cables.

Recently developed types of electric insulants have become available which have a relatively high dielectric strength (of the order of 1000 volts per .001") and, therefore, may be made so thin that they impose relatively little thermal insulation between a conductor and the outer surface of a cable comprising the conductor and the insulant around the conductor. Examples of such substances are silicone rubbers in strip or sheet form, P.V.C., and varnish or lacquer layers of silicone resin or epoxy resin. Further such insulation substances have many desirable properties besides high dielectric strength, for example they have a high moisture resistance and satisfactory mechanical strength.

Such insulants have comparatively low limits of operating temperature, often as low as 100° C. or less, so would appear to be unsuitable for use as insulators in an electric heating cable. I have found, however, that if advantage is taken of the high dielectric and mechanical strength, of silicone rubber, P.V.C., silicone resin varnish and epoxy resin varnish to apply them as thin coverings to electrical resistance material having a large superficial area in comparison with its cross sectional area, the rate of heat dissipation is such that the insulants remain undamaged by the heat produced in the conductor when the latter is run within its rating.

In Patent Specification No. 610,022 which discloses a flexible structure having a body portion of rubber and a plurality of thin flexible metallic filaments consisting essentially of aluminium extending substantially continuously through said body portion, said filaments being in the form of metallic ribbons having

a thickness which is small relative to the width thereof, it is proposed to cover the said filaments consisting essentially of aluminium with a bonding agent in a very thin coat to bond the filaments to the rubber of the body portion of the structure. Synthetic resin, halogenated rubber and various copolymers of polyvinyl compounds such as the chloride are included among the materials proposed as covering agents. The said filaments are for the purpose of conducting heat throughout the structure either for conducting heat therefrom or for supplying heat thereto, one way of supplying the heat being to pass an electric current through the filaments. The coating material is of course bonded into the rubber structure during the manufacture thereof and, therefore, before the filaments perform their heat conducting function.

According to the present invention an electric heating cable is provided comprising a thin ribbon or tape of resistance metal enclosed in a thin sheath of silicone rubber or polyvinyl chloride, or sheathed with asbestos or glass filament yarn impregnated or coated with epoxy resin varnish or silicone resin varnish, the cable offering a high superficial area for the escape of heat from it in relation to its cross sectional area. Owing to the invention an efficient heating element is produced without unduly high local temperatures being reached and without the resistance material or the insulant operating at an unduly high temperature.

The insulants, according to their nature, may be applied to the ribbon or tape as a varnish or lacquer coating or as an extruded coating while they may be used as impregnants for fibrous materials such as finely woven glass fibres or asbestos or felts covering the ribbon or tape.

A typical cable according to the invention comprises a ribbon of resistance material having a resistance of 0.2 ohms or more per foot run, e.g., cupro nickel $\frac{1}{8}$ " wide and 0.003" thick, and a sheath of insulating material bringing the overall thickness of the cable to 1.0 mm. or slightly less.

The insulation may be protected by a metallic or other sheath over part of the whole of the surface and this sheath may consist of two strips of metal at least one of which is slightly wider than the insulating material enclosing the resistance material and said strip may be folded around its edges to meet the other strip the meeting edges being if desired joined by soldering or otherwise. Alternatively the outer sheath or coating may be formed by extrusion of a suitable relatively stiff synthetic resin or other extrusion moulding material.

The insulating sheath may also be applied by sandwiching the resistance material between two strips or tapes of insulating material which are bonded together at the edges by heat and/or pressure and the faces of the insulating strips or at least the marginal parts of the faces of such strips may if necessary be pre-treated with a suitable adhesive or solvent.

Whatever method of applying the insulating material is adopted the insulating material together with the resistance material within it may be passed or drawn through a suitable die or between heated rollers to form an insulated conductor consisting of a thin and relatively wide flat strip and where a metallic or other sheathing is used this may also be forced through a die or drawn between rollers to form a compact cable having the desired properties.

One embodiment of cable according to the invention is shown in the accompanying drawings in which:—

Fig. 1 is a cross sectional view; and

Fig. 2 is a plan of the cable with the successive layers successively cut away to show the construction thereof.

A thin flat strip or tape 1 of resistance material such as cupro-nickel is enclosed within a mass or layer of insulating material 2 of silicone rubber for example and the whole is enclosed by a metal sheath which consists of a strip of copper 3 gripped at its edges by the infolded edges of a wider strip 4 as shown, the joint being sealed if desired for example by means of an adhesive or by soldering.

Due to the large superficial area of the resistance material 1 and of the whole cable including the sheath 3, 4 as well as the relative thinness of the insulating material 2 overlying the elongated faces of the resistance

material a high rate of heat transfer from the resistance material is obtained thus permitting an efficient heating cable to be produced without attaining unduly high temperatures in the insulating material 2.

A heating cable in which the conductor 1 consists of cupro-nickel strip $\frac{1}{8}$ " wide and .003 thick has been found to have four times the heat dissipating surface of a circular wire of equal cross section. The overall thickness of the cable need not exceed 1 mm.

WHAT I CLAIM IS:—

1. An insulated electric heating cable comprising a thin ribbon or tape of resistance metal enclosed in a thin insulating sheath of silicon rubber or polyvinyl chloride, or sheathed with asbestos or glass filament yarn impregnated or coated with silicone resin varnish or epoxy resin varnish, the cable offering a high superficial area for the escape of heat from it in relation to its cross sectional area.

2. An insulated electric heating cable according to Claim 1 wherein the insulating material is coated on the resistance material as a laquer coating or is extruded around said resistance material.

3. An insulated electric heating cable according to Claim 1 wherein the insulating material is applied to the resistance material in the form of strips or tapes extending beyond the edges of the resistance material and bonded together by heat and/or pressure.

4. An insulated electric heating cable according to any of Claims 1 to 3 wherein the insulating material is clad with a metal sheath over part or all of its surface to assist in heat dispersion.

5. An insulated electric heating cable according to Claim 4 wherein the metal sheath comprises a wider metal strip and a narrower metal strip, the edges of the wider strip being folded over on to the narrower strip and fixed to the latter for example by soldering.

6. Insulated electric heating cables substantially as herein described or as herein described with reference to the accompanying drawings.

BROMHEAD & CO.,

Chartered Patent Agents,

19—23, Ludgate Hill, London, E.C.4.

PROVISIONAL SPECIFICATION

No. 15581, A.D. 1954.

Improvements in Electric Heating Cables

I, HENRY HOPE BRUCE, Grand Buildings, Trafalgar Square, London, W.C.2, a British Subject, do hereby declare this invention to be described in and by the following statement:—

This invention relates to the construction and application of heating cables or tapes for contact heating of various types of industrial

and laboratory equipment, for soil heating, for space heating generally, and for similar purposes.

The present invention provides heating cable in the form of unusually thin flat tape so that heat is readily released at quite moderate temperatures, thus reducing thermal stresses in both the conductor or conductors and the

insulation. In one form of the invention the heat dissipating surface is further extended by enclosing the tape with pressure contact in a flat metal sheath, for example of aluminium, appreciably wider than the core, thus providing in effect continuous fins on a spinal conductor. In another form of the invention the tape is clamped to sheet metal to provide heated skirtings or heated covings, ceilings, radiant strip or panels for warming buildings. Preferably the tape has a resilient or compressible surface to retain pressure-contact under working conditions.

In one example of the invention the conducting or resistance wire is of nickel-chrome, about $\frac{1}{8}$ " wide and five or six mil thick and is coated with enamel, preferably based on silicone resin or the like or is covered with glass silk or the like about five to ten mil thick and coated or impregnated with moisture resisting silicone varnish or the like or covered with extruded plastic material and enclosed in a flat metal sheath which provides both extended surface and earthing continuity. Such heating cable may be cast directly in con-

crete or the like for warming buildings or may be fed into pipes for increased protection against injury.

In another example, resistance wire of about 26 gauge, insulated concentrically to a thickness of about 5 mil is clamped in a folded strip of light-gauge metal to form a sheath about $\frac{1}{2}$ " or more wide and only about $\frac{1}{16}$ " thick.

In another example there are two conducting or resistance wires, circular or flat, in the same sheath which is flat and has its surface extended to suit the application concerned.

In yet another form of the invention there are two conductors, which in this instance may be of copper, aluminium or other metal of high conductivity partially insulated from one another by semi-conducting material, such as silicone resin containing a filler of carbon, graphite or the like, which is heated by the passage of electricity through it from one conductor to the other. This core is coated with moisture-repellent dielectric material and is shaped as stated to dissipate heat without excessive temperature rise in the interior.

H. H. BRUCE.

PROVISIONAL SPECIFICATION

No. 21521, A.D. 1954.

Improvements in Electric Heating Cables

I, HENRY HOPE BRUCE, Grand Buildings, Trafalgar Square, London, W.C.2, a British Subject, do hereby declare this invention to be described in the following statement:—

This invention relates to the construction of electric cables for carrying current with a relatively small drop in voltage and of cables having a large voltage drop to provide heat rather than to carry current for use in other apparatus.

This invention provides a cable which consists of a thin flat strip or tape of copper, aluminium or other appropriate material which conducts electricity with much or little resistance per unit length, according to purpose, with longitudinal electrical insulation and outer sheathing of aluminium, copper or other suitable material. This sheathing may be appreciably wider than the core, in accordance with my Provisional Application No. 15581/54.

The ribbon wire is located between two self-adhesive insulating tapes of substantially known type such as semi-cured silicone rubber either unsupported or coated on glass silk or the

like or silicone pressure adhesive tape, in either case the tape being about $\frac{1}{8}$ " or so wider than the ribbon wire so that it overlaps to provide sealed edges.

In another form of the invention, two such ribbon wires, side by side and spaced about $\frac{1}{8}$ " apart, are held between double-width tapes with double-width sheathing.

In yet another form of the invention two ribbon wires are located one above the other, separated by a third strip of adhesive insulating tape.

When required the cable is heat-cured after sheathing.

Joints in the cable are made in any convenient manner, such as by peeling back the slit sheathing and insulation, bending the ribbon wire so that one wire hooks to the other, replacing the insulation, augmented as necessary, replacing the sheathing and closing a simple pressure clamp.

H. H. BRUCE.

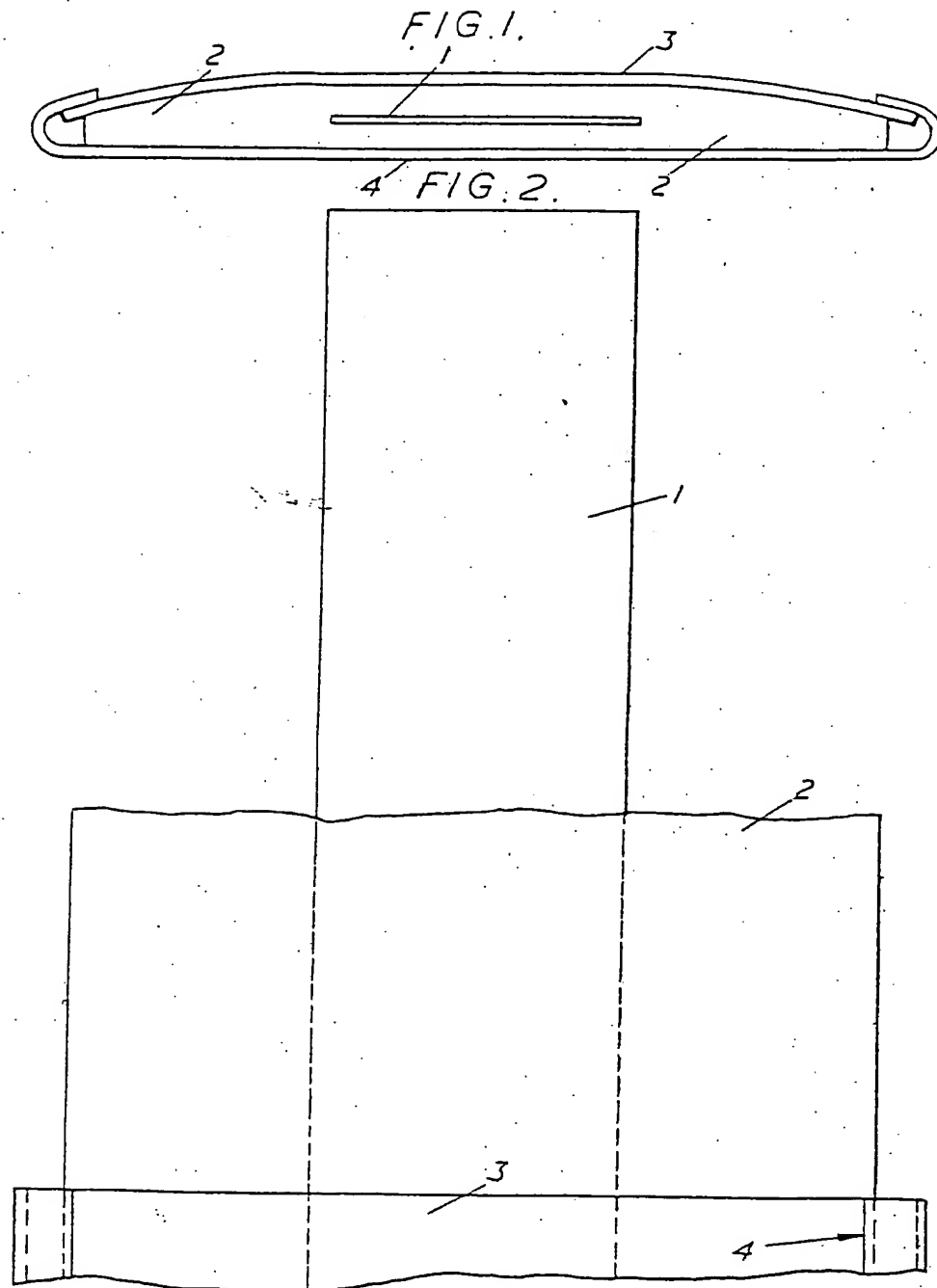
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1 SHEET

COMPLETE SPECIFICATION

*This drawing is a reproduction of
the Original on a reduced scale.*



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